Fishes of *Neoclinus bryope* Species Complex from Shirahama, Japan, with Description of Two New Species

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Abstract Three species are recognized within the fish previously described as *Neoclinus bryope* (Jordan et Snyder) from Shirahama, Japan. These three species are separable primarily by the combination of two meristic characters, the number of vertebrae and the total number of cephalic sensory pores. The true *N. bryope* has 47 to 49 vertebrae and 49 to 57 cephalic sensory pores. One new species, *N. okazakii* has 45 to 47 vertebrae and 58 to 78 pores. Another new species, *N. chihiroe* has 44 to 46 vertebrae and 49 to 55 pores. The true *N. bryope* is redescribed and the two new species are described on the basis of the specimens from Shirahama.

Hitherto, 7 species were recognized in the genus *Neoclinus*. *N. blanchardi* Girard, *N. uninotatus* Hubbs, and *N. stephensae* Hubbs are known only from California (Hubbs, 1953; Stephens and Springer, 1971), *N. nudus* Stephens et Springer only from Taiwan (Stephens and Springer, 1971), and *N. bryope* (Jordan et Snyder), *N. lacunicola* Fukao, and *N. toshimaensis* Fukao only from Japan (Fukao, 1980).

The small benthic shore fish *Neoclinus bryope* was originally described as *Zacalles bryope* by Jordan and Snyder (1902), based on the specimens from Misaki, Kanagawa Prefecture, Japan. Hubbs (1953) redescribed the fish as a member of *Neoclinus* in his revision of the genus. Stephens (1961) reported two specimens of *N. bryope* from Okinawa which are slightly different from the specimens from mainland Japan in some meristic characters and in the degree of squamation. Fukao (1980) pointed out that the specimens from Shirahama, Wakayama Prefecture, were rather similar to the fish from Okinawa reported by Stephens (1961) than to the fish from Misaki described by Hubbs (1953). An electrophoretic study described in detail by Fukao and Okazaki (1987) revealed that *N. bryope* described by Fukao (1980) from Shirahama consists of three genetically distinct populations. These three populations should be treated as three species of *Neoclinus bryope* species complex (newly designated), since they are sympatric in Shirahama.

In the present study, recognition of these three species was also undertaken in an attempt to compare morphological identification of specimens and those identified by electrophoresis. Upon the results and the comparison with the holotype of *Zacalles bryope* (=*Neoclinus bryope*), the true *N. bryope* was redescribed and the other two members of *N. bryope* species complex were described as new species based on the specimens collected from the waters of Shirahama.

Materials and methods

Specimens used in this study were collected by dip net with anesthetic quinaldine in the waters around the Seto Marine Biological Laboratory in Shirahama, Wakayama Prefecture, Japan (approximately 33°41′N and 135°20′E). The holotype (Stanford Natural History Museum, SU 7076) and the 20 paratypes (SU 7102) of *Zacalles bryope* (=*Neoclinus bryope*) were also examined for the comparison.

Vertebrae, dorsal and anal fin ray counts were made by radiographs. One short splintlike spine of the pelvic fin bound into investing membrane of the first soft ray is usually visible only after dissection or staining. Cephalic sensory pore series were shown in Fig. 1. Fukao (1980) classified a pore under the anterior nostril into the infraorbital series counts by mistake. Now it was correctly included into the nasal series. The boundaries between supraorbital series and nasal series and between posttemporal series and the body lateral line were also made an amendment as shown in Fig. 1. Cephalic sensory pores and lateral line pores were counted after manifestation by cyanine solution which infiltrated into the lateral line canal

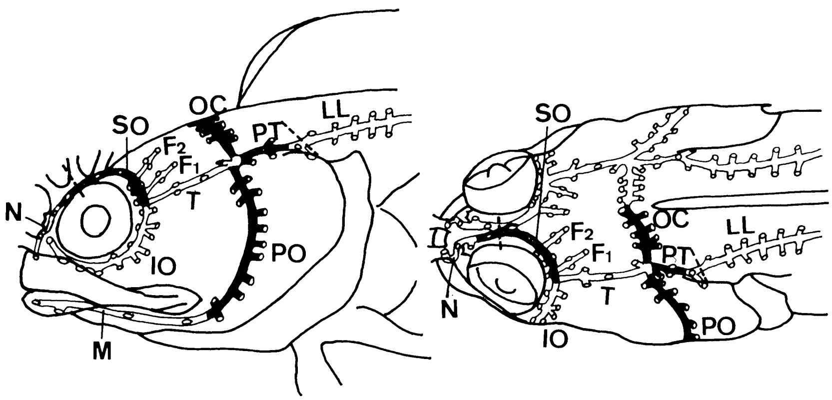

Fig. 1. Schematic illustration of cephalic sensory pore series. F_1, frontal 1 series; F_2, frontal 2 series; IO, infraorbital series; LL, body lateral line; M, mandibular series; N, nasal series; OC, occipital series; PO, preopercular series; PT, posttemporal series; SO, supraorbital series; T, temporal series. F_1, F_2, IO, LL, M, N and T canals are shown by the open manifestation. OC, PO, PT and SO canals are shown by the solid manifestation. Broken lines show the boundaries between N and SO series and between PT and LL series expressed by Fukao (1980), which are made amendment in the present study.

on the specimen wiped off. Dentition and gill rakers on the fisrt gill arch of right side were examined after staining by alizarine-red. Number of specimens used for examination of these characters is 10, 7 and 7 specimens of *N. bryope*, *N. okazakii* and *N. chihiroe*, respectively. Nasal cirri were counted for all free tips.

Except as noted below, the method of measurements followed Hubbs and Lagler (1958). The body depth is the distance between the base of pelvic fin and the closest point on the dorsal contour of body. The body depth at anal origin is the least distance between anal origin and the dorsal contour of body. The opercular membrane is excluded from the measurement of the head length and the postorbital length of head. The head width is the greatest dimension of the cheek.

Proportion of each measurement is expressed in percent of standard length. Regression line formulae of each proportion to standard length are calculated. When significant differences (95% level) are observed in slope or elevation between the regression line of male and that of female, the formulae are given for each sex.

The sexual difference of *Zacalles bryope* (=*Neoclinus bryope*) has been reported by Tomiyama (1951). In the report, the best discriminating characters, urogenital sinus and anus, were described and illustrated. However, the described characteristics are hardly available in sex discrimination of the smaller individuals. In the present study, it was noticed that a certain characteristic of female was erroneously described by Tomiyama (1951). In the female, only the urethra opens at the tip of a tubular process with or without fold and papillae and the oviduct opens between the process and the anus, different from the anterior side of urogenital tube forming the posterior wall of the anal cavity. Although the tubular process lies so close to the anus, a rather wide opening of oviduct could be found between them even in the smaller specimens by careful examination after manifestation by cyanine solution. In the male, urogenital sinus opens at the tip of a cone just behind the anus as described by Tomiyama (1951). The above noted sexual difference is common among the present three species.

Some specimens used for electrophoresis were so damaged by tissue sampling that overall counts and measurement could not be examined. However, available counts and measurements in these specimens were included in the results.

Recognition of three species of *Neoclinus bryope* species complex

Diagnostic characters of the fish previously recognized as *N. bryope* have been as follows. Adult not exceed 80 mm in SL, no conspicuous sexual

dimorphism in upper jaw, gill rakers about 20, one ocellus on the membrane between the first two dorsal spines, 3 (rarely 4) multifid orbital cirri arranged in a single row, and no nuchal cirri (Hubbs, 1953; Stephens and Springer, 1971; Fukao, 1980).

It has been shown by the results of electrophoresis (Fukao and Okazaki, 1987) that the three genetically distinct populations exist in *N. bryope* described by Fukao (1980) from Shirahama, Japan. For convenience' sake, the three genetically distinct populations were designated as populations B, O and C. Some meristic characters of these three populations are summarized in Table 1. Those of the holotype of *Zacalles bryope* (=*Neoclinus bryope*, SU 7076) are also shown in Table 1.

In vertebrae, dorsal fin elements and anal fin soft ray counts, the number increased from population C to population B through population O. The mean numbers of these characters were significantly different among the three populations. Especially, the number of total vertebrae clearly separated population B from population C. Population O occupied the position just intermediate between population B and population C. The mean of total pectoral fin ray counts of population B was significantly higher than those of both population C and population O, while the difference between population C and population O was little in this character. In total cephalic sensory pore counts, the number of population O was clearly higher than those of both population B and population C. The mean number of this character was hardly different between population B and population C. The lateral line pore counts increased from population C to population O through population B. The mean number was significantly different among the three populations. Especially, this character clearly separate between population C and population O. The number of gill rakers was not significantly different among the three populations. Thus, the significant differences were found among the three populations in most of above noted meristic characters. Moreover, it appeared that the genetically distinctive populations were also clearly separable by the combination of two meristic characters. That is to say, the total cephalic sensory pore number separates population O from populations B and C, and then separates the population B from population C in the number of total vertebrae. However, two questionable individuals appeared in the specimens not identified by electrophoresis. Namely, the total number of cephalic sensory pores of them (60 and 58) were within the range between the upper limit of population B (57) and the lower limit of population O (61) established from the electrophoresed specimens. Fortunately, both individuals have 46 vertebrae, which is the modal number of population O and outside the range of

Table 1. Summary of meristic characters in three genetically distinct populations (B, O and C) with counts of SU 7076 (holotype of *Zacalles bryope*). Number of specimens examined is in parenthesis. No overlapping counts are expressed by bold-faced letters. * ⧻, $p<0.001$; ⧺, $p<0.01$; —, $p>0.05$

Character	SU 7076	Range and mean±SD			Level of significance*		
		B (n)	O (n)	C (n)	B:O	O:C	C:B
Total vertebrae	48	**47–49** (32) 48.0±0.5	45–47 (11) 46.4±0.7	**44–46** (24) 45.0±0.5	⧻	⧻	⧻
D. fin elements	42	40–44 (30) 42.6±0.9	39–42 (11) 40.7±1.0	37–41 (21) 39.8±0.7	⧻	⧺	⧻
A. fin soft rays	30	29–31 (29) 30.2±0.6	28–30 (11) 28.5±0.8	26–29 (24) 27.7±0.8	⧻	⧺	⧻
Total P_1 fin rays	28	26–30 (38) 27.9±0.8	24–26 (12) 25.6±0.8	24–28 (27) 25.9±0.7	⧻	—	⧻
Total cephalic sensory pores	51	49–57 (38) 52.5±2.1	**61–75** (12) 67.6±4.1	50–54 (26) 52.0±1.2	⧻	⧻	—
Lateral line pores	40	38–49 (38) 42.8±2.3	**44–50** (12) 47.5±1.9	**33–42** (26) 38.0±2.3	⧻	⧻	⧻
Gill rakers	—	17–20 (10) 18.3±1.1	17–24 (7) 19.6±2.5	16–21 (7) 17.9±1.7	—	—	—

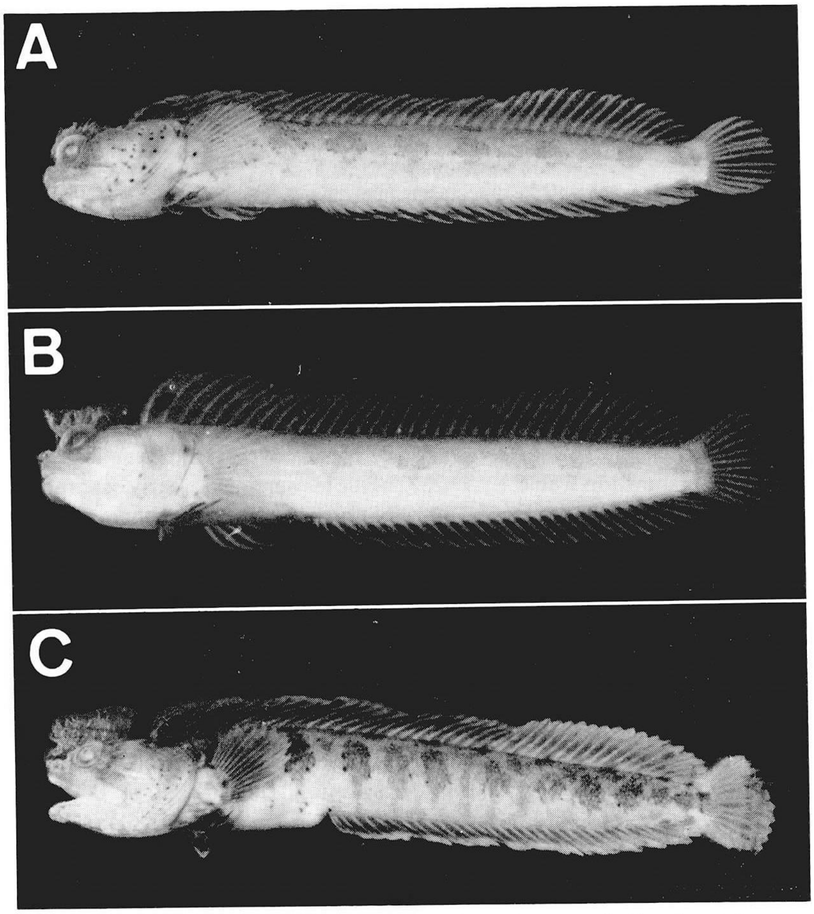

Fig. 2. Fishes of *Neoclinus bryope* species complex. A, holotype of *N. okazakii* sp. nov. (FAKU 111774); B, holotype of *N. chihiroe* sp. nov. (FAKU 111775); C, *N. bryope* (FAKU 49503).

population B, and 26 total pectoral rays, which is not typical of population B but of populations O and C. So, they may be able to be assigned to population O.

The holotype of *Zacalles bryope* (=*Neoclinus bryope*, SU 7076) fitted with population B in the above noted meristic characters. In consequence, population B is the true *N. bryope* and populations O and C are new species (*okazakii* and *chihiroe* respectively). All the 20 paratypes of *Z. bryope* (SU 7102) are also regarded as the true *N. bryope*.

Description of three species of *Neoclinus bryope* species complex

Neoclinus okazakii sp. nov.
(Japanese name: Araiso-koke-ginpo)
(Fig. 2A)

Neoclinus bryope: Fukao, 1980: 193–198 (in part: FAKU, Faculty of Agriculture, Kyoto University, 48437, 48521, 48936, 48945, 48966, 49371, 49491, 49502, 49536, 49537, 49539 and 39542).

Specimens examined. Holotype: FAKU 111774, ♂, 59.1 mm, June 22, 1977.

Paratypes: FAKU 48437, ♀, 35.8 mm, July 12, 1973; FAKU 48521, ♂, 35.2 mm, Apr. 15, 1975; FAKU 48936, ♀, 41.1 mm, Apr. 15, 1975; FAKU 48945, ♂, 46.1 mm, June 1, 1975; FAKU 48966, ♀, 44.8 mm, Aug. 1, 1975; FAKU 49371, ♀, 42.3 mm, Aug. 2, 1975; FAKU 49491, ♂, 58.1 mm, May 20, 1977; FAKU 49492, ♂, 34.1 mm, May 19, 1977; FAKU 49493, ♀, 30.2 mm, May 22, 1977; FAKU 49494, ♀, 27.8 mm, May 21, 1977; FAKU 49502, ♂, 61.9 mm, Dec. 4, 1976; FAKU 49504, ♂, 25.8 mm, May 9, 1977; FAKU 49505, ♂, 49.2 mm, Feb. 3, 1977; FAKU 49536, 6♂, 37.0–54.5 mm, June 13, 1977; FAKU 49537, ♂, 40.5 mm, June 13, 1977; FAKU 49539, 3♂, 49.4–57.2 mm, June 15, 1977; FAKU 49540, 2♂,

35.1–39.1 mm, June 15, 1977; FAKU 49542, 2♂, 30.8–49.1 mm, June 18, 1977; FAKU 49546, ♂, 57.8 mm, June 22, 1977; FAKU 49547, ♀, 49.0 mm, June 24, 1977; FAKU 49548, ♂, 53.9 mm, June 24, 1977; FAKU 49550, 2♂, 39.0–42.8 mm, July 8, 1977; FAKU 111776, ♂, 29.3 mm, June 15, 1977; FAKU 111777, ♂, 34.3 mm, June 19, 1977.

Non-types: 7♂, 38.8–56.8 mm, 6♀, 37.2–49.4 mm, May 3, 1984 and July 11–13, 1984.

Diagnosis. Adult not exceeding 70 mm in SL, no conspicuous sexual dimorphism in upper jaw, gill rakers 17 to 24, 3 (rarely 4) multifid orbital cirri arranged in single row, no nuchal cirri, total vertebrae 45 to 47, total cephalic sensory pores 58 to 78, and pectoral fin ray 13 (rarely 12 or 14).

Description. Counts and measurements of holotype are presented in Table 2. Meristic counts are shown in Tables 3 to 5 and Figs. 3 and 4. Ranges and mean values with standard deviation of proportional measurements, and regression line formulae of each proportion to standard length are presented in Table 6.

The proportional changes with growth are observed in the following 13 parts. Total length (i.e. caudal fin length), body depth, caudal peduncle depth, predorsal length, preanal length, head length, orbital length, longest dorsal ray length, first anal ray length, longest pectoral ray length, and longest pelvic ray length show negative allometry. Postorbital length of head, and dorsal fin base length show positive allometry. Besides these, significant difference between sexes was observed in slope and/or elevation of the regression line for the following 3 body parts. While distance from anal origin to pelvic insertion of female shows positive allometry, that of male is regarded as constant (in specimens over 45 mm in SL, females mostly larger than males). While anal fin base length of male shows positive allometry, that of female shows gradual negative allometry (in specimens over 45 mm in SL, males mostly larger than females). While longest dorsal spine length of male shows positive allometry, that of female shows negative allometry (in specimens over 45 mm in SL, males larger than female).

Nasal cirri slender, sometimes bifurcated or trifurcated; total of 5 to 13 (11 in holotype) free tips on posterior rim of anterior nostrils (Fig. 3). Orbital cirri 3 or 4 (mostly 3; 3 in holotype) arranged in single row, much branched; usually first cirrus longest and most branched.

Upper jaw with 19 to 24 teeth on each side in outer row; anterior 5 to 7 larger incisorlike teeth; posterolateral 13 to 17 smaller conical teeth; a patch of minute villiform teeth posterior and medial to anterior outer row. Lower jaw with 19 to 24 teeth on each side in outer row; anterior 4 to 7 larger incisorlike teeth, followed by 1 to 5 moderately developed canines; 10 to 15 posterolateral smaller conical teeth; a patch of small villiform teeth (less than those on upper jaw in number, slightly larger in size) posterior and medial to anterior outer row, those on posterior margin somewhat longer. Vomer with 4 or 5 (mostly 5) conical teeth in an anterior crescentic

Table 2. Counts and measurements of holotype of two new species of *Neoclinus*.

	N. okazakii FAKU 111774	*N. chihiroe* FAKU 111775
Sex	male	male
Counts		
Dorsal rays	XXIV, 17	XXIV, 16
Anal rays	II, 29	II, 28
Pectoral rays	13–13	13–13
Pelvic rays	I, 3–I, 3	I, 3–I, 3
Principal caudal rays	7+6=13	7+6=13
Vertebrae	12+35=47	12+33=45
Measurements (in mm)		
Standard length	59.1	45.1
Total length	67.2	52.2
Body depth	8.8	7.2
Body depth at anal origin	8.0	6.2
Caudal peduncle depth	3.9	3.4
Caudal peduncle length	3.0	2.2
Predorsal length	9.8	8.0
Preanal length	24.8	19.1
Anal origin to pelvic insertion	13.9	10.1
Head length	13.0	10.4
Head width	8.8	7.2
Postorbital length of head	8.0	5.9
Orbital length	3.2	2.7
Upper jaw length	7.8	5.9
Dorsal fin base length	49.9	36.2
Anal fin base length	32.9	25.2
Longest dorsal spine length	7.8; 3rd	5.5; 3rd
Longest dorsal soft ray length	5.8; 7th	4.9; 9th
First anal spine length	2.8	2.1
First anal soft ray length	4.1	3.2
Longest pectoral ray length	7.3; 8th	6.2; 10th
Longest pelvic ray length	6.1; 2nd	5.4; 2nd

row; median tooth larger. Palatine with 9 to 14 conical teeth mostly in single row, rarely in 2 rows consisting of a larger lateral row which is complete, and a smaller mesial row which is incomplete; usually third, fourth or rarely fifth (in lateral row) tooth largest.

Gill rakers 5–11+11–15=17–24 on first arch (sometimes 1 to 4 on upper limb and 2 to 4 on lower limb rudimentary).

Cephalic sensory canal complete; total pore counts 58 to 78 (66 in holotype). Pore counts of each series are presented in Table 5. Those of holotype are as follows: occipital series 7; preopercular series 13; mandibular series 5; posttemporal series 4; temporal series 6; nasal series 3; infraorbital series 14; supraorbital series 8; frontal 1 series 4; frontal 2 series 2.

Raised distinct lateral line on body running posteriorly from upper margin of opercle to a point below eleventh to thirteenth (twelfth in holotype) dorsal spine; first 0 to 1 (mostly 1; 1 in holotype) single median pore, followed by 20 to 25 (22 in holotype) paired pores, sometimes the row of paired pores interrupted by 1 to 3 (2 in holotype) unpaired pores (opening only above or only below the canal, or single median pore), lasting 1 to 2 single median pore (mostly 1; 1 in holotype); total pore number 43 to 52 (48 in holotype) (Fig. 4).

Head and all fins naked. Scales on body nonimbricated and somewhat difficult to observe; areas above lateral line, below the line from anus to upper edge of opercle, and areas covering inclinater muscle of dorsal and anal fins almost scaleless.

Spinous dorsal fin smooth or slightly waving; spines soft and flexible except for last 1 (30 inds. including holotype), 2 (16 inds.), or 3 (1 ind.) ones which are stiff; in larger males including holotype, anterior spines somewhat elevated and, in females

Table 3. Frequency distributions of dorsal, anal and pectoral fin elements in species of *Neoclinus bryope* species complex. SU 7076, holotype of *Zacalles bryope*; SU 7102, paratypes of *Zacalles bryope*.

	D. spines					D. soft rays						Total D. elements					
	23	24	25	26	27	14	15	16	17	18	19	39	40	41	42	43	44
SU 7076			1						1						1		
SU 7102		1	13	6				1	9	7	3				6	11	3
N. bryope	2	7	60	12	1			4	26	47	6		1	3	24	46	8
N. okazakii		25	22				2	24	19	3			10	29	8		
N. chihiroe	11	22	4			1	5	24	9			7	27	2	1		

	A. soft rays						Total P_1 rays						
	27	28	29	30	31	32	24	25	26	27	28	29	30
SU 7076				1							1		
SU 7102				13	6	1			1	5	14		
N. bryope			16	42	26	1			7	9	68	1	3
N. okazakii		16	23	8			4	1	40	2			
N. chihiroe	9	23	3				3	5	30	2	1		

Table 4. Frequency distributions of number of vertebrae in species of *N. bryope* species complex. A.V., abdominal vertebrae; C.V., caudal vertebrae.

	A.V.		C.V.						Total V.					
	12	13	32	33	34	35	36	37	44	45	46	47	48	49
SU 7076	1						1						1	
SU 7102	20						14	6					14	6
N. bryope	70	14				23	50	11				12	58	14
N. okazakii	47			2	20	25				2	20	25		
N. chihiroe	38		4	29	5				4	29	5			

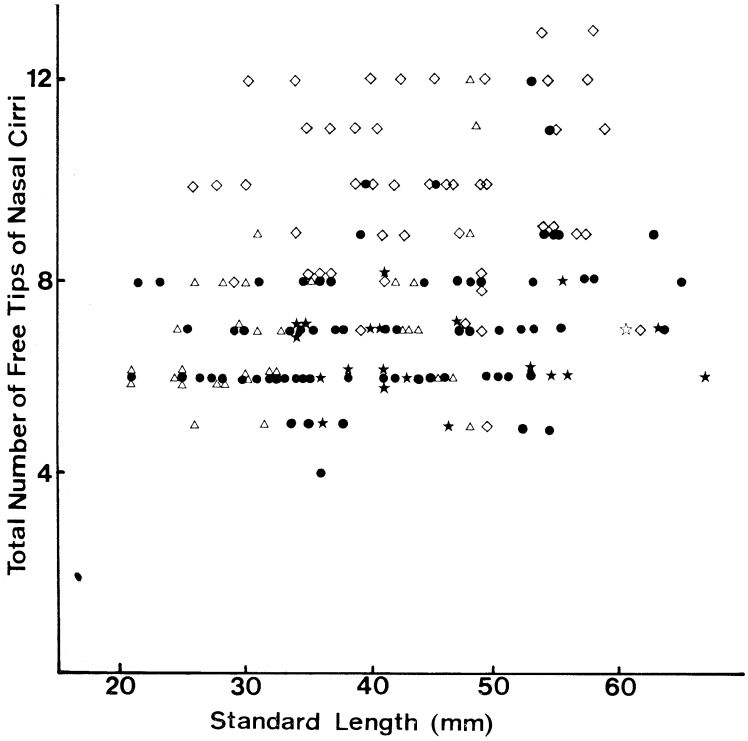

Fig. 3. Total number of free tips of nasal cirri in three species of *Neoclinus bryope* species complex. ●, *N. bryope*; △, *N. chihiroe*; ◇, *N. okazakii*; ☆, holotype of *Zacalles bryope* (=*Neoclinus bryope*, SU 7076); ★, paratypes of *Z. bryope* (SU 7102).

Table 5. Frequency distributions of number of cephalic sensory pores in species of *Neoclinus bryope* species complex. SU 7076, holotype of *Zacalles bryope*; SU 7102, paratypes of *Z. bryope*. OC, occipital series; PO, preopercular series; M, mandibular series; PT, post-temporal series; T, temporal series; N, nasal series; IO, infraorbital series; SO, supraorbital series; F_1, frontal 1 series; F_2, frontal 2 series.

	OC					PO								M			PT				
	5	6	7	8	9	10	11	12	13	14	15	16	17	5	6	7	2	3	4	5	6
SU 7076		1					1							1				1			
SU 7102	7	11	2			4	16							17	3			16	4		
N. bryope	26	51	12	1		11	61	16	2					80	10		1	81	7	1	
N. okazakii		2	21	20	5		1	4	20	13	6	3	1	22	25	1		4	39	4	1
N. chihiroe	8	29	3	1		2	37	2						39	1			34	7		

	T						N			IO						SO					
	2	3	4	5	6	7	2	3	4	11	12	13	14	15	16	5	6	7	8	9	10
SU 7076		1						1				1				1					
SU 7102	2	15	1	2				20		4	13	3				1	14	5			
N. bryope	19	60	10	1			1	87	2	9	61	18		2		6	37	37	9	1	
N. okazakii		7	26	9	4	2		48			3	14	19	8	4		4	11	15	13	5
N. chihiroe		39	1					40		3	32	5				1	15	18	6		

	F_1					F_2					Total range
	1	2	3	4	5	1	2	3	4	5	
SU 7076	1					1					51
SU 7102	19	1				15	4	1			49–54
N. bryope	76	12	2			68	19	3			49–57
N. okazakii	2	9	11	19	7	6	20	16	5	1	58–78
N. chihiroe	35	4	1			38	2				49–55

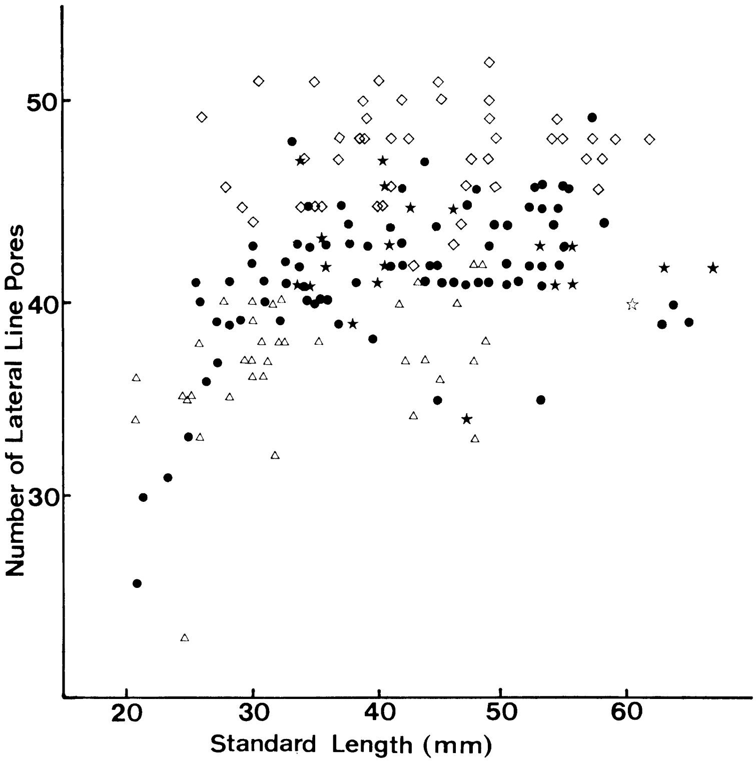

Fig. 4. Number of lateral line pores in three species of *Neoclinus bryope* species complex. Symbols as in Fig. 3.

and young, spines subequal; last 1 to 3 stiffed spines noticeably shorter; a narrow membrane along anterior edge of first spine. Soft dorsal fin usually higher than spinous dorsal fin; gently arched and slightly serrated; last ray attached to caudal peduncle by a membrane in various extent (only at its base to thoroughly; one half in holotype), rarely proximal third to two-thirds of last ray adhering to caudal peduncle. Dorsal fin membrane not or slightly notched between spinous and soft dorsal fins (slightly notched in holotype). Last spine not or reaching margin of the fin membrane; in most of females and most of larger males including holotype, the spine clearly separated from the margin of fin membrane (Fig. 5). Anal fin serrated; 2 soft and flexible spines shorter and closer than soft rays; second spine longer than first spine; soft ray gradually increasing in height posteriorly, but last 3 or 4 (3 in holotype) rays becoming shorter; last ray attached to caudal peduncle in various extent (one fourth in holotype). Caudal fin rounded, rather truncate in smaller specimens; rays 5–6+13+5–6; membranes between principal rays slightly incised. Pectoral fin rounded; ninth or tenth (mostly ninth; ninth in holotype) ray longest; lower 3 to 4 (4 in holotype) rays thicker than upper ones; fin membrane more deeply incised ventrally than dorsally. Pelvic fin consisting of a short thin splintlike spine and 3 solft rays; of the latter, second ray longest and third ray shortest; membrane deeply incised between first and second rays and slightly incised between second and third rays.

Color in life: Color pattern varies from almost plain to strongly barred. Body light tan to dusky tan, sometimes tinged with pink, rather rarely mottled with pale or rarely with black spots anteriorly. Usually upper half of body darker than lower half, especially in typical barred pattern specimens. In barred pattern specimens, 7 to 10 (9 in holotype) darker vertical irregular or diamond like bars and sometimes 1 to 4 less distinct intermediate ones, which are restricted anteriorly, superimposed on the ground color; sometimes the upper middle broadest part of bar coalesced with each other to make a longitudinal stripe. Five to 8 (6 in holo-

Table 6. Ranges and mean values with standard deviation of proportions, and regression lines of proportions to standard length in *Neoclinus okazakii*.

	n	Range	Mean±SD	Regression line	r	p
Standard length (in mm)	48	25.8– 61.9	44.2±9.1	—	—	—
Total length	46	112.3–115.9	113.9±1.0	Y=−0.067X+116.9	−0.604	0.000
Body depth	47	14.0– 17.4	15.6±0.8	Y=−0.042X+ 17.5	−0.479	0.000
Body depth at anal origin	48	12.6– 16.4	14.6±0.7	Y=−0.021X+ 15.5	−0.278	0.055
Caudal peduncle depth	48	6.2– 8.1	7.3±0.4	Y=−0.023X+ 8.4	−0.521	0.000
Caudal peduncle length	48	5.0– 6.5	5.6±0.4	Y=−0.003X+ 5.8	−0.070	0.634
Predorsal length	48	15.8– 21.2	18.3±1.3	Y=−0.133X+ 24.2	−0.907	0.000
Preanal length	48	40.1– 46.1	42.6±1.2	Y=−0.046X+ 44.7	−0.361	0.011
Anal origin to pelvic insertion	♂ 33	20.3– 24.5	22.9±1.0	Y=−0.001X+ 23.0	−0.013	0.943
	♀ 14	22.1– 26.6	24.2±1.3	Y= 0.093X+ 20.3	0.519	0.057
Head length	48	22.0– 26.7	24.1±1.2	Y=−0.109X+ 28.9	−0.853	0.000
Head width	36	14.3– 19.1	15.8±1.2	Y=−0.004X+ 16.0	−0.042	0.807
Postorbital length of head	48	12.4– 15.4	14.0±0.5	Y= 0.027X+ 12.8	0.503	0.000
Orbital length	48	5.0– 7.6	6.1±0.6	Y=−0.053X+ 8.4	−0.836	0.000
Upper jaw length	♂ 34	12.1– 14.3	13.2±0.4	Y=−0.008X+ 13.6	−0.140	0.430
	♀ 14	12.3– 14.2	13.1±0.7	Y=−0.034X+ 14.5	−0.385	0.174
Dorsal fin base length	48	72.9– 84.8	80.3±2.3	Y= 0.196X+ 71.6	0.784	0.000
Anal fin base length	♂ 34	50.8– 56.5	54.8±1.1	Y= 0.073X+ 51.4	0.636	0.000
	♀ 14	51.6– 55.9	53.8±1.3	Y=−0.050X+ 55.9	−0.278	0.335
Longest dorsal spine length	♂ 32	9.7– 14.2	11.3±1.5	Y= 0.111X+ 6.3	0.732	0.000
	♀ 14	8.0– 10.5	9.4±0.8	Y=−0.076X+ 12.6	−0.705	0.004
Longest dorsal soft ray length	47	9.2– 11.4	10.1±0.5	Y=−0.037X+ 11.8	−0.651	0.000
First anal spine length	48	3.2– 5.4	4.5±0.5	Y=−0.013X+ 5.1	−0.271	0.062
First anal soft ray length	47	5.6– 8.2	7.0±0.6	Y=−0.031X+ 8.4	−0.469	0.000
Longest pectoral ray length	48	11.9– 17.3	14.3±1.1	Y=−0.105X+ 19.0	−0.843	0.000
Longest pelvic ray length	48	8.8– 14.3	11.7±1.3	Y=−0.109X+ 16.5	−0.756	0.000

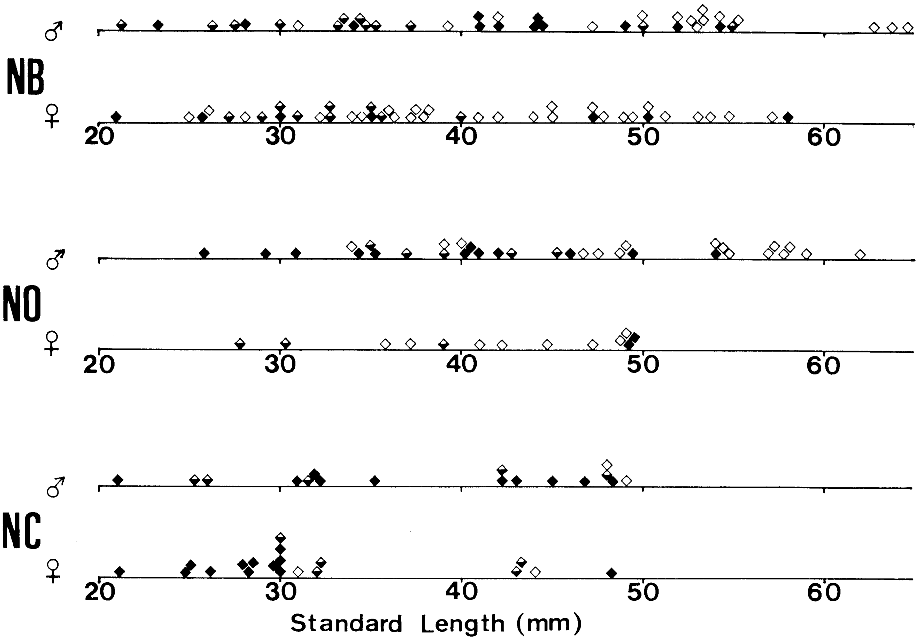

Fig. 5. Condition of last dorsal spine in three species of *Neoclinus bryope* species complex. ◆, last spine reaching margin of the dorsal fin membrane; ⬙, last spine faintly not reaching margin of the dorsal fin membrane (tip of spine goes beyond the distal fifth of the fin); ◇, tip of last spine clearly separated from margin of the dorsal fin membrane (tip of spine does not go beyond the distal fifth of the fin). NB, *N. bryope*; NO, *N. okazakii*; NC, *N. chihiroe*.

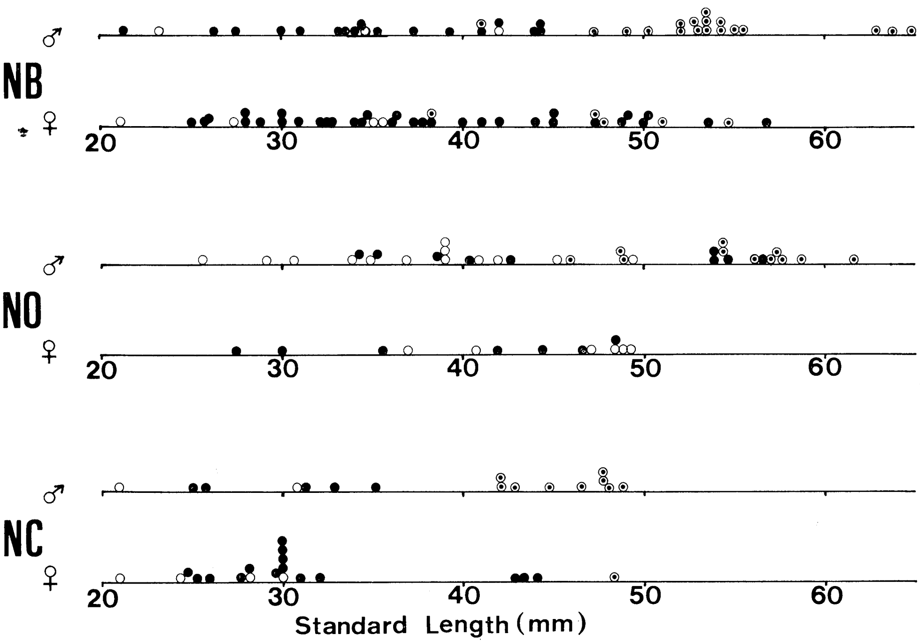

Fig. 6. Types of ocellus on dorsal fin in three species of *Neoclinus bryope* species complex. ○, obscure; ●, black ocellus without paler margin; ⊙, black ocellus with paler margin. NB, *N. bryope*; NO, *N. okazakii*; NC, *N. chihiroe*.

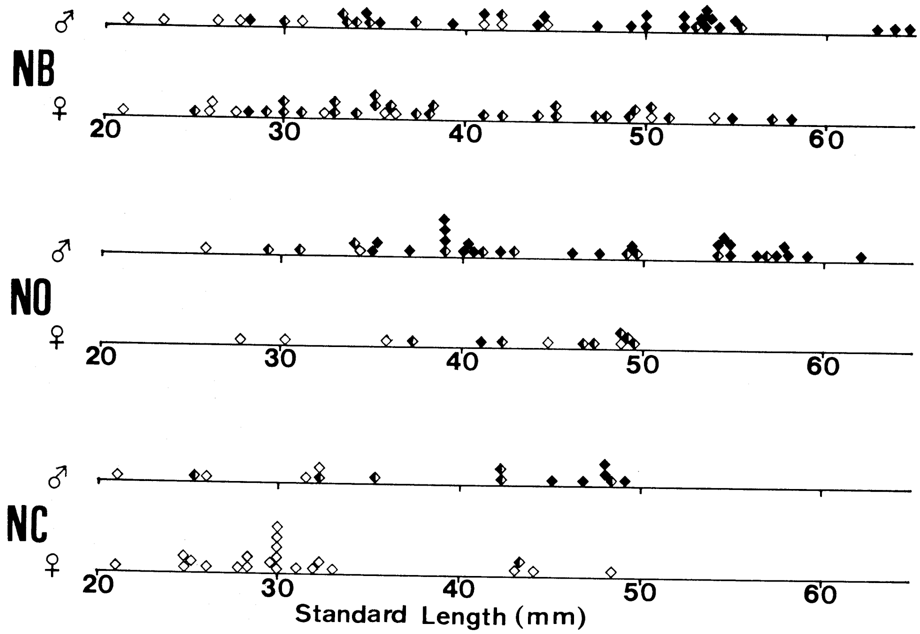

Fig. 7. Condition of a black submarginal band on anal fin in three species of *Neoclinus bryope* species complex. ◆, complete; ⬖, incomplete; ◇, other markings (several oblique dot lines, random dots or no marking). NB, *N. bryope*; NO, *N. okazakii*; NC, *N. chihiroe*.

type) suddlelike bars across the dorsal base. Head darker than body; black spots on cheek, opercle and sometimes on opercular membrane; pale spots on cheek, opercle and jaws. Opercular membrane margined with black and its upper edge distinctly black. Throat barred dark and light or uniformly brown. Unpaired fins lighter and brighter than body except for spinous dorsal fin, especially its anterior part darker. Zero (usually somewhat blackish but obscure) to 2 (mostly 1; 1 in holotype) ocelli on anterior dorsal fin; ocellus with or without paler margin; margined ocellus observed in larger males including holotype (Fig. 6). In addition to the ocellus, most of larger specimens (in both sex) with pale specklings on anterior darker spinous dorsal fin. Soft dorsal fin and caudal fin rays mottled with dark and light or not. Anal fin with or without submarginal dusky band; complete band mostly observed in larger male including holotype; other markings (several oblique dot line, random dot, or no markings) sometimes observed in female and rarely in smaller male (Fig. 7). Pectoral fin transparent with yellow or orange rays. Pelvic fin sooty; rays black or colored like in body.

Etymology. Named *okazakii* in honor of Dr. Toshio Okazaki who carried out electrophoresis and led to the recognition of this species.

Neoclinus chihiroe sp. nov.

(Japanese name: Shizumiiso-koke-ginpo)
(Fig. 2B)

Neoclinus bryope: Fukao, 1980: 193–198 (in part: FAKU 49538 and 49543).

Specimens examined. Holotype: FAKU 111775 (Formerly FAKU 49538-b), ♂, 45.1 mm, June 14, 1977.

Paratypes: FAKU 49538, 2♂, 21.0–31.5 mm, 3♀, 24.8–48.3 mm, June 14, 1977; FAKU 49543, ♂, 48.2 mm, ♀, 26.0 mm, June 19, 1977; FAKU 49544, 2♂, 26.1–48.0 mm, June 19, 1977; FAKU 49545, ♀, 31.9 mm, June 19, 1977; FAKU 111778, ♀, 24.8 mm, June 24, 1977; FAKU 111779, ♀, 29.9 mm, June 24, 1977.

Non-types: 13♂, 25.3–49.0 mm, 14♀, 25.2–43.9 mm, May 3, 1984 and July 9–13, 1984.

Diagnosis. Adult not exceeding 70 mm in SL, no conspicuous sexual dimorphism in upper jaw, gill rakers 16 to 21, 3 (rarely 4) multifid orbital cirri arranged in single row, no nuchal cirri, total vertebrae 44 to 46, total cephalic sensory pores 49 to 55, pectoral fin rays 13 (rarely 12 or 14).

Description. Counts and measurements of

holotype are presented in Table 2. Meristic counts are shown in Tables 3 to 5 and Figs. 3 and 4. Ranges and mean values with standard deviation of proportional measurements, and regression line formulae of each proportion to standard length are presented in Table 7.

The proportional changes with growth are observed in the following 10 parts. Body depth, caudal peduncle depth, predorsal length, preanal length, head length, orbital length, first anal ray length, longest pectoral ray length, and longest pelvic ray length show negative allometry. Dorsal fin base length shows positive allometry. Besides these, significant difference between sexes was observed in the following 4 body parts. While distance from anal origin to pelvic insertion of female shows positive allometry, that of male is regarded as constant (in specimens over 40 mm in SL, females are larger than males). While upper jaw length of female shows negative allometry, that of male shows constant or slightly negative allometry. While anal fin base length and longest dorsal spine length of male show positive allometry, those of female show negative allometry. In the latter 3 body parts, males are larger than females in specimens over 40 mm in SL.

Total free tips of nasal cirri 5 to 12 (6 in holotype) (Fig. 3). Orbital cirri 3 or 4 (mostly 3; 3 in holotype) much branched; usually first cirrus longest and most branched.

Upper jaw with 18 to 23 teeth on each side in outer row; anterior 5 to 7 larger incisorlike teeth; posterolateral 13 to 17 (rarely 1 or 2 inside the outer row) smaller conical teeth; a patch of minute villiform teeth posterior and medial to anterior outer row. Lower jaw with 21 to 32 teeth on each side in outer row; anterior 4 to 7 larger incisorlike teeth, followed by 2 to 7 moderately developed canines; 15 to 22 posterolateral smaller conical teeth; a patch of small villiform teeth (less than those on upper jaw in number, slightly larger in size) posterior and medial to anterior outer row, those on posterior margin somewhat larger. Vomer with 5 (4 inds.), 6 (2 inds.) or 7 (1 ind.) conical teeth in an anterior crescentic row; mesial teeth larger. Palatine with 11 to 18 teeth in single or double row; in double row, lateral row complete and mesial row incomplete; second, third or fourth tooth (in lateral row) largest.

Gill rakers 6–8+10–13=16–21 on first arch (sometimes 1 on upper limb and 2 to 4 on lower limb rudimentary).

Cephalic sensory canal complete; total pore counts 49 to 55 (51 in holotype). Pore counts of each series are presented in Table 5. Those of holotype are as follows: occipital series 6; preopercular series 11; mandibular series 5; posttemporal series 3; temporal series 3; nasal series 3; infraorbital series 12; supraorbital series 6; frontal 1 series 1; frontal 2 series 1.

Raised distinct lateral line on body running posteriorly from upper margin of opercle to a point below eighth to eleventh (ninth in holotype) dorsal spine; first 0 to 2 (mostly 1; 1 in holotype) single median pores, followed by 11 to 20 (17 in holotype) paired pores, rarely interrupted by 1 unpaired pore, lasting 1 to 3 (mostly 1; 1 in holotype) single median pores, total pore number 23 to 42 (36 in holotype) (Fig. 4).

Head and all fins naked. Scales on body nonimbricated and somewhat difficult to observe; a few to several scales on posterior area above lateral line; an area below the line from anus to upper edge of opercle (somewhat convex downward) scaleless; base of dorsal and anal fins narrowly scaleless.

All fins similar to those of *N. okazakii*. Last 1 (28 inds. including holotype) or 2 (11 inds.) dorsal spines stiff and noticeably shorter. Last dorsal spine not or reaching margin of fin membrane; in a few females and larger males, tip of the spine clearly separated from the margin of membrane (in holotype, tip of the spine reaching the margin of fin membrane) (Fig. 5). Caudal fin with 5–6+13+5–6 rays. Pectoral fin rounded; eighth to tenth (mostly ninth; ninth in holotype) ray longest. Pelvic fin with 1 splintlike spine and 3 soft rays; second soft ray longest.

Color in life: Color pattern varies from almost plain to strongly barred. Body light tan to dusky tan, or pinkish, mostly mottled with pale spots. Usually upper half of body darker than lower half, especially in typical barred pattern specimens. In barred pattern specimens, 7 to 12 (9 in holotype) diamond like (mostly) or merely irregular bars and sometimes 1 to 9 (2 in holotype) less distinct intermediate ones superimposed on the ground color. Six to 9 (mostly 6; 6 in holotype) suddlelike bars across the dorsal base. Head darker than body; black spots on cheek, opercle and sometimes on opercular membrane; pale spots on cheek, opercle and jaws. Opercular membrane slightly margined

Table 7. Ranges and mean values with standard deviation of proportions, and regression lines of proportions to standard length in *Neoclinus chihiroe*.

	n	Range	Mean±SD	Regression line	r	p
Standard length (in mm)	38	20.9– 49.0	34.1±8.6	—	—	—
Total length	36	111.1–118.0	114.8±1.5	Y= 0.008X+114.5	0.052	0.763
Body depth	37	14.7– 18.4	16.6±1.0	Y=−0.073X+ 19.0	−0.642	0.000
Body depth at anal origin	37	13.4– 16.9	14.8±0.9	Y=−0.030X+ 15.8	−0.278	0.084
Caudal peduncle depth	38	6.9– 8.6	7.7±0.4	Y=−0.017X+ 8.3	−0.345	0.033
Caudal peduncle length	38	4.6– 6.9	5.9±0.6	Y=−0.014X+ 6.4	−0.224	0.175
Predorsal length	38	16.5– 23.8	20.0±1.8	Y=−0.197X+ 26.7	−0.942	0.000
Preanal length	38	41.1– 46.9	43.9±1.5	Y=−0.090X+ 47.0	−0.522	0.000
Anal origin to pelvic insertion	♂ 16	22.4– 25.1	23.7±0.8	Y=−0.014X+ 24.2	−0.156	0.563
	♀ 21	21.4– 28.0	24.6±1.8	Y= 0.168X+ 19.3	0.659	0.001
Head length	38	22.4– 28.6	25.1±1.6	Y=−0.166X+ 30.7	−0.883	0.000
Head width	14	14.3– 19.1	15.6±1.2	Y=−0.048X+ 17.2	−0.422	0.132
Postorbital length of head	37	12.6– 14.6	13.6±0.5	Y=−0.015X+ 14.2	−0.272	0.103
Orbital length	37	6.0– 9.0	7.0±0.7	Y=−0.070X+ 9.3	−0.852	0.000
Upper jaw length	♂ 17	12.2– 14.6	13.3±0.7	Y=−0.017X+ 14.0	−0.214	0.408
	♀ 21	11.6– 13.7	12.9±0.6	Y=−0.050X+ 14.5	−0.583	0.005
Dorsal fin base length	38	70.8– 85.2	78.9±2.8	Y= 0.223X+ 71.3	0.687	0.000
Anal fin base length	♂ 17	48.2– 56.7	54.0±2.2	Y= 0.148X+ 48.5	0.636	0.006
	♀ 21	49.8– 57.4	53.8±2.1	Y=−0.051X+ 55.5	−0.177	0.442
Longest dorsal spine length	♂ 15	8.9– 12.7	10.8±1.2	Y= 0.133X+ 6.5	0.810	0.000
	♀ 19	7.7– 11.0	9.6±0.8	Y=−0.074X+ 12.0	−0.722	0.000
Longest dorsal soft ray length	34	9.3– 12.7	10.9±0.7	Y=−0.012X+ 11.3	−0.157	0.376
First anal spine length	38	3.6– 5.7	4.6±0.5	Y=−0.005X+ 4.7	−0.091	0.587
First anal soft ray length	37	5.9– 8.6	7.1±0.6	Y=−0.033X+ 8.2	−0.508	0.001
Longest pectoral ray length	36	13.7– 18.1	15.7±1.1	Y=−0.099X+ 19.1	−0.773	0.000
Longest pelvic ray length	37	10.8– 16.3	13.9±1.5	Y=−0.145X+ 18.9	−0.822	0.000

with black and its upper edge distinctly black. Throat barred dark and light or uniformly brown. Unpaired fins semitransparent slightly tinged with color like in body, except for anteriormost spinous dorsal fin which is darker or whitish. Zero to 1 ocellus (mostly 1; 1 in holotype) on anterior spinous dorsal fin; ocellus with or without paler margin; margined ocellus mostly observed in larger male including holotype (Fig. 6). In some larger specimens, paler spots on anterior darker part of spinous dorsal fin. Soft dorsal fin and caudal fin rays mottled with dark and light. Anal fin with or without submarginal dusky band; complete band observed in larger male including holotype (Fig. 7). Pectoral fin transparent with tan or pinkish rays. Pelvic fin sooty or colored like in body.

Etymology. After Chihiro which is given name of Mrs. Toshio Okazaki. Incidentally I may remark that "chihiro" means a thousand fathoms. Although this species is living in littoral zone, its habitat extended somewhat deeper than those of the other two members of *N. bryope* species complex.

Neoclinus bryope (Jordan et Snyder, 1902)
(Japanese name: Koke-ginpo)
(Fig. 2C)

Zacalles bryope Jordan and Snyder, 1902: 448.
Calliblennius bryope: Barbour, 1912: 187.
Neoclinus bryope: Hubbs, 1953: 17–18; Fukao, 1980: 193–198 (in part: FAKU 48438, 48958, 48961 and 49503).

Specimens examined. FAKU 48438, 2♀, 41.1–45.0 mm, June 2, 1973; FAKU 48958, ♂, 53.2 mm, May 18, 1975; FAKU 48961, ♀, 50.3 mm, July 9, 1975; FAKU 49486, 3♂, 23.2–35.2 mm, 2♀, 27.3–32.2 mm, May 18, 1977; FAKU 49487, 3♂, 21.3–33.2 mm, 2♀, 29.0–31.0 mm, May 18, 1977; FAKU 49488, 2♂, 27.4–37.2 mm, 3♀, 25.7–34.9 mm, May 18, 1977; FAKU 49489, 3♂, 28.1–34.8 mm, 2♀, 25.1–30.9 mm, May 18, 1977; FAKU 49490, ♂, 34.4 mm, 4♀, 20.9–30.1 mm, May 18, 1977; FAKU 59503, ♂, 62.8 mm, Feb. 13, 1977; FAKU 49541, ♂, 43.9 mm, June 15, 1977; FAKU 49549, ♂, 44.2 mm, June 27, 1977. Not registered: 27♂, 32.7–64.8 mm, 30♀, 32.7–58.0 mm, May 3, 1984, June 2–3, 1984 and July 11–13, 1984.

Diagnosis. Adult not exceeding 70 mm in SL, no conspicuous sexual dimorphism in upper jaw, gill rakers 17 to 20, 3 (rarely 4) multifid orbital cirri arranged in single row, no nuchal cirri, total vertebrae 47 to 49, total cephalic sensory pores 49 to 57, and pectoral fin ray 14 (rarely 13).

Description. Meristic counts are presented in Tables 3 to 5 and Figs. 3 and 4. Ranges and mean values with standard deviation of proportional measurements, and regression line formulae of proportion to standard length are presented in Table 8.

Significant difference between sexes was observed in the following 4 parts. While distance from anal origin to pelvic insertion of male shows negative allometry, that of female shows positive allometry (in specimens over 50 mm in SL, females are mostly larger than male). While upper jaw length and longest dorsal spine length of male show positive allometry, those of female is regarded as constant (in specimens over 50 mm in SL, males are larger than females). Anal fin base length of both male and female shows positive allometry, but the proportion of male is slightly smaller than that of female. Besides these 4 parts, the proportional changes with growth are observed in other 16 parts with an exception, head width, which is regarded as constant. Dorsal fin base length and postorbital length of head show positive allometry. The other 14 parts show negative allometry.

Total free tips of nasal cirri 4 to 12 (Fig. 3). Orbital cirri 3 or 4 (mostly 3), much branched; usually first cirrus longest and most branched.

Upper jaw with 16 to 22 teeth on each side in outer row, antreior 5 or 6 larger incisorlike teeth, posterolateral 11 to 17 smaller conical teeth; a patch of minute villiform teeth posterior and medial to anterior outer row. Lower jaw with 20 to 25 teeth on each side in outer row; anterior 4 to 6 larger incisorlike teeth, followed by 1 to 6 moderately developed canines, 10 to 17 posterolateral smaller conical teeth (rarely including 1 or 2 larger teeth); a patch of small villiform teeth (less than those on upper jaw in number, slightly larger in size) posterior and medial to anterior outer row, those on posterior margin somewhat longer. Vomer with 4 to 6 (mostly 5) conical teeth in an anterior crescentic row; median tooth larger. Palatine with 8 to 11 conical teeth in single row; usually third or fourth tooth largest.

Gill rakers 6–8+10–13=17–20 on first arch (rarely last 1 on upper limb and sometimes last 1 to 3 on lower limb rudimentary).

Cephalic sensory canal complete; total pore

Table 8. Ranges and mean values with standard deviation of proportions, and regression lines of proportions to standard length in *Neoclinus bryope*.

	n	Range	Mean±SD	Regression line	r	p
Standard length (in mm)	85	20.9– 64.8	41.5±10.6	—	—	—
Total length	73	110.7–117.5	114.0± 1.4	Y=−0.071X+116.9	−0.520	0.000
Body depth	79	13.9– 18.7	16.3± 0.9	Y=−0.055X+ 18.6	−0.667	0.000
Body depth at anal origin	81	12.9– 16.4	14.9± 0.6	Y=−0.030X+ 16.1	−0.421	0.000
Caudal peduncle depth	85	6.4– 9.1	7.2± 0.5	Y=−0.025X+ 8.3	−0.540	0.000
Caudal peduncle length	85	4.6– 7.1	5.6± 0.5	Y=−0.022X+ 6.6	−0.505	0.000
Predorsal length	85	15.7– 23.9	19.4± 1.7	Y=−0.154X+ 25.8	−0.940	0.000
Preanal length	83	41.5– 47.2	43.9± 1.3	Y=−0.044X+ 45.8	−0.362	0.000
Anal origin to pelvic insertion	♂ 37	21.0– 26.0	23.7± 1.2	Y=−0.040X+ 25.5	−0.384	0.019
	♀ 42	22.3– 26.8	24.5± 1.3	Y= 0.058X+ 22.2	0.426	0.004
Head length	85	21.4– 28.2	24.9± 1.3	Y=−0.109X+ 29.5	−0.865	−0.000
Head width	52	14.5– 18.3	16.1± 0.9	Y=−0.006X+ 16.4	−0.074	0.603
Postorbital length of head	84	12.8– 15.0	13.8± 0.7	Y= 0.013X+ 13.3	0.246	0.023
Orbital length	85	5.1– 8.6	6.4± 0.7	Y=−0.075X+ 8.8	−0.853	−0.000
Upper jaw length	♂ 40	12.1– 15.1	13.8± 0.8	Y= 0.033X+ 12.3	0.491	0.001
	♀ 45	12.3– 14.9	13.3± 0.6	Y=−0.001X+ 13.3	−0.018	0.908
Dorsal fin base length	84	73.4– 83.7	79.1± 2.2	Y= 0.148X+ 73.0	0.726	0.000
Anal fin base length	♂ 40	51.2– 57.3	54.3± 1.5	Y= 0.082X+ 50.6	0.615	0.000
	♀ 43	50.8– 56.9	53.6± 1.5	Y= 0.086X+ 50.2	0.561	0.000
Longest dorsal spine length	♂ 34	9.1– 15.7	11.4± 1.8	Y= 0.142X+ 5.0	0.815	0.000
	♀ 40	8.5– 11.2	9.7± 0.7	Y= 0.009X+ 9.3	0.132	0.416
Longest dorsal soft ray length	76	8.1– 12.7	10.0± 0.8	Y=−0.051X+ 12.1	−0.729	0.000
First anal spine length	79	3.2– 4.9	4.0± 0.4	Y=−0.010X+ 4.5	−0.268	0.016
First anal soft ray length	80	5.1– 8.2	6.7± 0.6	Y=−0.030X+ 7.9	−0.484	0.000
Longest pectoral ray length	81	11.8– 18.3	14.7± 1.5	Y=−0.120X+ 19.7	−0.841	−0.000
Longest pelvic ray length	84	9.6– 16.3	12.3± 1.5	Y=−0.109X+ 16.8	−0.802	0.000

counts 49 to 57. Pore counts of each series are presented in Table 5.

Raised distinct lateral line on body running posteriorly from upper margin of opercle to a point below ninth to twelfth dorsal spine; first 0 to 2 (rarely 2) single median pores, followed by 12 to 23 paired pores, sometimes interrupted by 1 to 2 unpaired pores, last 1 to 7 (mostly 1) single median pores; total pore number 30 to 49; the number increasing as they grow up to about 30 mm in SL and then becoming constant (Fig. 4).

Head and all fins naked. Most of scales on body slightly imbricated and clearly visible; a dozen or so scales extending on the area above lateral line; scales on belly becoming smaller toward the ventralmost part; only the ventralmost part of belly scaleless.

All fins similar to *N. okazakii*. Last 1 (73 inds.) or 2 (10 inds.) dorsal spines stiff and noticeably shorter. Last dorsal spine not or reaching margin of fin membrane; tip of the spine clearly separated from the edge of membrane in most of females and most of larger males (Fig. 5). Caudal fin with 6–7+13+5–7 rays. Pectoral fin with 13 to 15 (mostly 14) rays; eighth to tenth (mostly ninth) ray longest. Pelvic fin with 1 splintlike spine and 3 soft rays; second soft ray longest.

Color in life: Color pattern varies from almost plain to strongly barred. Ground color of body light tan to dusky tan, rarely tinged with orange or reddish purple, with or without pale specklings and/or black ones. Usually upper half of body darker than lower half, especially in typical barred pattern specimens. In barred pattern specimens, 9 to 12 vertical irregular bars and 4 to 9 less distinct intermediate ones, which are especially noticeable anteriorly and ventrally, superimposed on the ground color; sometimes the broadest part of distinct bar coalesced with each other to make a longitudinal stripe. Seven to 10 suddlelike bars across the dorsal base. Head darker than body: black spots on cheek, opercle and sometimes on opercular membrane; pale spots on cheek and opercle. Opercular membrane slightly margined with black and its upper edge slightly blackish or not. Jaws and throat barred dark and light. Spinous dorsal fin colored like in body, with or without extensions of body bars; 0 to 2 (mostly 1) black ocelli on anterior darker part; ocellus with paler margin commonly observed in larger male; smaller fish rarely without distinct ocellus (Fig. 6); larger male and some larger female also with pale specklings on anterior darker part of the fin. Soft dorsal fin and caudal fin lighter than body; rays mottled with dark and light. Anal fin with or without submarginal dusky band; the complete band mostly observed in larger male; the incomplete band mostly observed in female; other markings rarely observed (Fig. 7). Pectoral fin nearly transparent with yellow, orange or red rays. Pelvic fin sooty; rays black or colored like in body.

Discussion

N. bryope described by Fukao (1980) was proved to contain three species using electrophoresis (Fukao and Okazaki, 1987) and morphological examination.

Most of counts and morphometrics were different among these three cryptic species (Tables 3–5, 9; Figs. 3, 4). No single character seems to have absolute diagnostic value, however, since their variation considerably overlapped between two of these three species. This is true for other characters such as color pattern or condition of scales. In this study, the morphological diagnosis for the three species could be primarily established by the combination of two meristic characters, the total number of cephalic sensory pores and the number of vertebrae. Each of these two characters is the typical example of the above note. The former distinguishes *N. okazakii* from the other two species, but the critical extremes of *N. okazakii* and *N. bryope* are contiguous to each other (Table 5). *N. bryope* and *N. chihiroe* are almost overlapping in this character. The latter distinguishes *N. bryope* from *N. chihiroe*, but the critical extremes of them are contiguous to each other. Furthermore, the range of this character in *N. okazakii* lies intermediate between those for *N. bryope* and *N. chihiroe* (Table 4). Although the three species of *N. bryope* complex partition their main habitat, the partitioning of habitat among them is imperfect and they intermingled to some extent in each habitat (Fukao and Okazaki, 1987). Therefore, even if a large number of specimens from each habitat could be examined, each one of these two morphological characters may barely show the possibility of existence of two species. Conversely, the incomplete habitat par-

titioning reveals that differences in these two morphological characters among three species may not be directly correlated with the environmental factors which are different between habitats. In other words, it is highly probable that these characters are genetically fixed to the range for each species. Incidentally I may remark that the fishes analyzed by electrophoresis also contains some individuals which were not collected from their own main habitat but from the main habitat of others.

Mayr (1969) noted that various biochemical methods, particularly those testing protein specificity, are suitable for checking on the probability of a real difference between "stocks" discovered by one of the other methods. The present case is different from the above in the process of recognition of species. That is to say, the existence of three species was not recognized until the fishes of *N. bryope* species complex were analyzed by biochemical method, electrophoresis. They could be surely recognized by correlation between the analysis of electrophoresis and counts of two meristic characters. Thus, the present case demonstrates a particular process in the recognition of the cryptic species.

The author once described "*N. bryope*" from Shirahama and pointed out some discrepancies between fish from Misaki, Kanagawa Prefecture (Hubbs, 1953) and the specimens from Shirahama in the modal number of pectoral, dorsal and anal fin counts (Fukao, 1980). The discrepancies were tentatively attributed to geographical variation, leaving the question that no difference was noticed between the Shirahama specimens and the two Okinawan specimens reported by Stephens (1961). Hubbs (1953) noted that *N. bryope* inhabits in warm, clear tidepools which is considered as main habitat of the true *N. bryope* by Fukao and Okazaki (1987). In the previous study

Table 9. Comparisons of regression line for proportional measurements to standard length. NB, *Neoclinus bryope*; NO, *N. okazakii*; NC, *N. chihiroe*. ⧻, $p<0.001$; ⧺, $p<0.01$; +, $p<0.05$; –, $p>0.05$

		NB: NO		NO: NC		NC: NB	
		Slope	Elevation	Slope	Elevation	Slope	Elevation
Total length		–	–	–	⧺	–	⧺
Body depth		⧺	⧻	⧻	⧻	–	–
Body depth at anal origin		–	+	–	–	–	–
Caudal peduncle depth		–	–	⧻	⧻	⧻	⧻
Caudal peduncle length		+	–	–	–	+	+
Predorsal length		⧻	⧻	⧻	⧻	+	⧻
Preanal length		+	⧻	⧻	⧻	+	–
Anal origin to pelvic insertion	♂	–	⧺	–	+	–	–
	♀	–	–	⧺	–	⧺	–
Head length		⧻	⧻	⧻	⧻	⧻	–
Head width		–	–	–	–	–	–
Postorbital length of head		–	+	–	⧻	–	–
Orbital length		⧻	⧻	⧻	⧻	⧻	⧻
Upper jaw length	♂	⧺	⧻	–	–	–	–
	♀	–	–	+	–	+	+
Dorsal fin base length		⧺	⧻	⧺	⧻	⧺	–
Anal fin base length	♂	–	–	–	–	–	–
	♀	+	–	–	–	+	–
Longest dorsal spine length	♂	–	–	–	–	–	–
	♀	⧺	–	–	–	⧺	–
Longest dorsal soft ray length		⧺	–	⧻	⧻	⧻	⧻
First anal spine length		–	⧻	–	–	⧺	⧻
First anal soft ray length		+	+	–	–	⧺	⧻
Longest pectoral ray length		⧺	⧺	⧻	⧻	⧻	⧻
Longest pelvic ray length		⧺	⧻	⧻	⧻	⧻	⧻

(Fukao, 1980) the examined specimens of "*N. bryope*" were mostly collected (34 inds.) from the subtidal of moderately exposed reefs (main habitat of *N. chihiroe*) or of very exposed reefs (main habitat of *N. okazakii*) and two relatively smaller ones from tide pools. Consequently, only 6 individuals of the true *N. bryope* were examined. In the present study, the true *N. bryope* from Shirahama fitted with the fish from Misaki (Hubbs, 1953) in the modal number of pectoral fin ray counts (14), dorsal fin spine counts (25), and anal fin ray counts (30). *N. okazakii* and *N. chihiroe* from Shirahama fitted with the fish from Okinawa (Stephens, 1961) in the modal number of pectoral fin ray counts (13), dorsal fin spine counts (24), and anal fin ray counts (29 in the former and 28 in the latter). A subtle difference in the degree of squamation between specimens from Misaki and those from Shirahama was also noted in the previous study, following the note of Stephens (1961) on the difference in squamation observed between Okinawan specimens and specimens from mainland Japan of "*N. bryope*". Stephens (1961) noted that this difference in squamation (between Okinawan specimens and specimens from mainland Japan) might well be considered of specific value but *N. stephensae* shows a similar variation in scalation. In the present study, it became clear that scales of the true *N. bryope* from Shirahama were clearly visible as specimens from Misaki, while scales of *N. okazakii* and *N. chihiroe* were somewhat difficult to observe as two specimens from Okinawa reported by Stephens (1961). It could be safely said that these differences should not be attributed to the geographical variation but to specific difference. The fish from Okinawa reported by Stephens (1961) may be *N. okazakii*, *N. chihiroe* or the fourth form of *N. bryope* species complex. Finally it is very interesting to note that a Californian species, *N. stephensae*, also shows a similar variation in squamation.

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白浜産 *Neoclinus bryope* species complex 魚類とその 2 新種

深尾隆三

和歌山県白浜で採集された従来コケギンポ *Neoclinus bryope* 1 種と考えられていた魚類を検討したところ3種に分けられることが判明した. これら 3 種は形態学的には主として 2 つの数量形質 (脊椎骨数と頭部管器の開孔数) の組み合わせにより区別される. そこで, 白浜産の標本に基づき, 真のコケギンポの再記載と2新種, アライソコケギンポ *Neoclinus okazakii* とシズミイソコケギンポ *Neoclinus chihiroe* の記載を行なった.

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